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August 20, 1999

VIA HAND DELIVERY

Ms. Magalie Roman Salas, Secretary
Federal Communications Commission
Office of the Secretary - Room TWB-204
445 Twelfth Street, SW
Washington, DC 20554

Re: Ex Parte: CC Docket Nos. 98-121 and 98-56

Dear Ms. Salas:

On August 20, 1999, I sent the attached document to Daniel Shiman and Claudia Pabo of the Common Carrier Bureau's Policy and Program Planning Division. Please include this filing in the record of the above-referenced proceedings.

Two copies of this Notice are being submitted in accordance with Section 1.1206 of the Commission's rules.

Sincerely,

Karen T. Reidy

Karen T. Reidy

Attachment

cc: Daniel Shiman
Claudia Pabo
John Stanley
Andrea Kearney
Alexander Belinfante
Raj Kannan
Eric Einhorn

No. of Copies rec'd 0+1
List ABCDE

Effective Enforcement of Non-Discriminatory Performance by Incumbent Local Exchange Carriers

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I. Introduction

The goal of an enforcement program is to ensure compliance with particular rules that are, absent the program, contradictory to the self-interest of the regulated entity. Establishing a set of rules, however, is only the first step in effective enforcement. After the rules are established, the regulated entity will choose whether or not to comply with the rules. Once the regulated firm makes this decision and acts, the enforcement agency must be able to accurately assess whether or not compliance has occurred. Finally, if a determination of non-compliance is reached, a fine or penalty that extracts the entire reward from non-compliance must be assessed. Through an effective enforcement program, the incentives of the regulated entity are altered by making the expected value of non-compliance zero (or negative). With nothing to gain from breaking the rules, compliance is encouraged.

II. Optimal Fines

In a standard cost-benefit framework, an enforcement program will alter the benefits of non-compliance by extracting any gain from the offending action through a fine or penalty.[1] For example, if the expected value of breaking a rule is $50, then a fine of $50 or more would make non-compliance an unprofitable action. The $50 fine would be an effective deterrent, however, only if the regulated firm knows that it will be detected with 100% certainty. If there is only a 50% probability of being detected *and* punished, then the expected value of the

[1] For a detailed exposition on the economics of crime and punishment, see Gary S. Becker, "Crime and Punishment: An Economic Approach," *Journal of Political Economy*, Vol. 76 (1968).

fine is only \$25 [i.e., $0.5 \cdot \$50 + (1 - 0.5) \cdot \$0$], which is well below the \$50 benefit from non-compliance. Thus, in this scenario, compliance is not expected.

Within the standard economic framework of crime and punishment, the optimal penalty for noncompliance is

$$F^* = \frac{\text{Increased Profits}}{\text{Probability of Detection}} = \frac{\delta\pi}{\phi} \tag{1}$$

where the optimal fine (F^*) is (at least) equal to the financial gain of non-compliance ($\delta\pi$) divided by the probability of being detected and punished (ϕ). If the firm expects to gain \$50 from non-compliance, and has a 50% chance of being detected and punished, then the optimal fine will be \$100 (= \$50/0.50).

While the theoretically "optimal" fine will just equal ($\delta\pi/\phi$), it is better to err on the side of exceeding this amount. Any fine that falls short of F^* will ensure less than full compliance. Thus, F^* should be viewed as an absolute *minimum* fine. The relationship between the optimal fine and the probability of detection is illustrated in Figure 1. For some fixed expected gain ($\delta\pi$), the optimal fine will be a declining function of the probability of detection (ϕ).

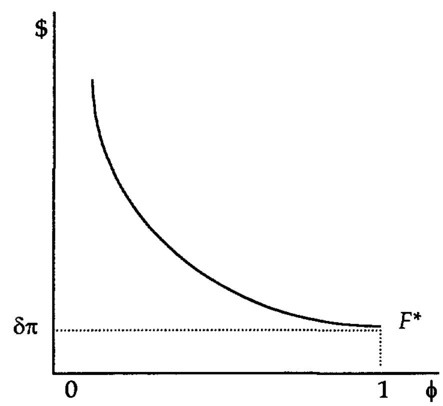

FIGURE 1.

1. A Simple Example

Parking a car in downtown Washington, D.C., provides a good example of the economics of crime and punishment. Assume that an individual plans to be in a shop for about an hour. The car can be parked in a parking deck for \$5 an hour or free on the street. Street parking is forbidden, however, and a fine of \$20 is levied for the offense. If there is only a 20% probability of being ticketed for illegal parking, then this individual will choose to park illegally since the expected "cost" of doing so is less than the $5 parking lot fee (0.20 · $20 = $4). If the parking authority could increase the fine to $30, however, illegal parking would be discouraged because the expected cost of doing so is $6. Alternatively, holding the fine at $20, the parking authority could hire more officers and increase the probability of detection. If the probability of detection can be increased to 50%, then the expected cost of illegal parking will be $10 and the offensive activity deterred. All of this presumes, of course, that the individual actually has to pay the fine. The numerator of equation (1) measures the probability of detection *and* punishment.

This simple parking example illustrates the fact that in order to establish a penalty structure that encourages individuals or firms to comply with particular rules of conduct, we need to approximate $\delta\pi$ and ϕ. Generally, we expect $\delta\pi > 0$ and $0 \leq \phi < 1$. If there is nothing to gain from non-compliance (i.e., $\delta\pi = 0$), then compliance is expected and no enforcement program is required. For a number of reasons, a perfect record of detection and punishment ($\phi = 1$) cannot be expected.

2. Intertemporal Gains

It is important to determine the intertemporal nature of the benefits from acts of non-compliance. In the parking example, the cost and benefits of the illegal activity are action specific. That is, there are few long-term consequences associated with the offending action. In the context of performance standards for the Regional Bell Operating Companies (RBOCs), the exact opposite is true. In general, the expected benefits of discriminatory treatment against competitive local exchange carriers (CLECs) are not case (and time) specific. Rather, this discrimination is a systematic attempt by the RBOC to slow the growth of competition in local exchange markets and to expand its own market share in long distance by disadvantaging its rivals. As a consequence, constructing punishment schemes on an occurrence specific basis will most likely be ineffective at deterring the discriminatory conduct of the RBOCs.

Discrimination against CLECs provides three potential sources of economic gain for the RBOC. First, the customer may view the CLEC (or the aggregation of CLECs) as offering sub-standard service and decide not to switch to the CLEC and to remain a customer of the RBOC. In this case, the RBOC will reap not only the benefit of keeping the customer for a few extra days or months, but potentially many years. For example, assume that non-compliance with a particular rule allows an incumbent firm to keep a single customer from defecting to an actual or potential rival. For simplicity, also assume that this customer generates $1 per month ($12 per year) in profits for the regulated firm. The size of $\delta\pi$ depends, of course, on how long the incumbent will be able to keep the customer and extract that $1 per month in profits. Assume that the non-compliant action ensures the incumbent will keep the customer for 5 more years. The discounted present value of the expected value of that customer over the next 5 years is $45.50.[2] Thus, with 100% probability of detection and punishment, F^* is $45.50 ($45.50/1). If the probability of detection and punishment falls to 75%, then the optimal fine is $61 ($45.50/0.75). If the customer remains with the incumbent for 10 years, then $F^* = \$98$ ($73.7/0.75).

The second potential source of economic gain for the RBOC is the systematic deterrence of competitive entry in the local exchange market. For example, assume that the non-compliant action of the incumbent diminished the good reputation of the actual or potential rival. As a consequence, this single act of non-compliance protects, say, ten customers from defecting to the rival. If each customer generates $1 per month in profit, and remains with the incumbent for five years, then the optimal fine is $455 if detection and punishment is certain. If the probability of detection is 0.75, the fine is $607. What is important here is that the fine, while levied against a single act of discrimination, is based on the more widespread effects of the discriminatory act. In this simple example, a single act of discrimination is more appropriately viewed as ten acts of discrimination.

A simple figure helps illustrate the point. In Figure 2, the increase in CLEC market share in the local exchange market is measured along the vertical axis and time (t) is measured on the horizontal axis. If the RBOC provided parity service to the CLECs, then the growth in CLEC market share is measured by the line **OX**. Alternatively, if the RBOC discriminates in the quality of service provided CLECs, the market share of rivals follows path **OZ**.[3] The benefit to the RBOC from discriminating against the CLEC can be measured at some arbitrarily chosen time in the future (say t^*). At t^*, if parity service is provided, CLEC market share has risen by an amount **0a**. If the RBOC discriminates against the CLEC, then the market becomes less conducive to competition and the CLECs gain only **0b** market share. In this case, the benefit to the RBOC of discrimination (at time t^*) against the CLEC is the financial value of the market share (**a – b**).

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[2] Assumes an annuity of five-year length, a 10% discount rate compounded annually.

[3] With extremely poor performance, it is possible that CLECs will choose to exit the market so that CLEC market share actually declines over time rather than increasing at a slower rate than without discrimination.

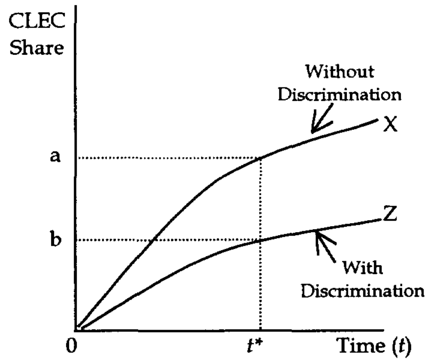

FIGURE 2.

As illustrated by the figure, providing poor service to CLECs in the earliest stages of competitive evolution, the RBOC may be able to extend the benefits of a few acts of discrimination to perhaps thousands of customers. For example, assume a CLEC, attempting to assess the ability of the RBOC to provision customers, orders 100 loops in a single month. If the RBOC successfully provisions the loops in a reasonable time frame, then the CLEC may increase its order next month to 1,000 loops. If the service remains acceptable, then 10,000 loops may be ordered the next month. Continued quality service from the RBOC may eventually allow the CLEC to *mass market* its competitive local exchange service using television, radio, and print ads.[4] With mass marketing, the CLEC may be able to increase its customer base by 100,000 loops in a given month.

This chain of events is broken, however, if the RBOC provides poor service to the CLEC on the first order of 100 loops. The CLEC, concerned about its reputation, will be reluctant to increase its loop orders by large amounts for fear of continued service problems. What could be an order of 100,000 loops in a few months shrivels into a few hundred. In the end, the RBOC will have retained thousands of customers by discriminating against fewer than one hundred. Under a case-specific enforcement approach, the RBOC will pay fines only for the twenty or so customers that received poor service in the first month. Yet, the economic gain from that discriminatory act was the profits from hundreds of thousands of customers.

A third source of financial reward for the RBOC is increased market share in the long distance business. If the RBOC has 271 approval, then by reducing the quality of its rivals' local exchange services it may be able to acquire the local and

[4] At present, CLECs are restricted primarily to highly targeted telemarketing advertising.

long distance business of its rivals' disgruntled customers. Thus, in addition to penalties based on protected market share in local exchange services, the established penalties must be high enough to extract the full financial reward to the RBOCs of gains in the long distance market acquired through discrimination against its local and long distance rivals.

3. FINES AND INTERTEMPORAL BENEFITS

Because the future is unknown, the exact determination of either $\delta\pi$ or ϕ is not possible. However, this fact does not imply that efforts to quantify these variables can be avoided. Properly sized penalties are necessary for an effective enforcement program.

In order to evaluate the effectiveness of a fine at deterring discriminatory conduct by the RBOC, the following simple formula can provide rough guidance:

$$F^* = \frac{\sum_{t=1}^{T} \pi_t \cdot n_t \cdot (1+r)^{-t}}{\phi} \tag{2}$$

where F^* is the optimal fine, t is time, n_t is the number of customers directly or indirectly affected by the discriminatory act in time period t, π_t is the profit per customer during some time period t, r is the discount rate, ϕ is the probability of detection, and T is the time horizon. The numerator of equation (2) is simply the discounted present value of the future stream of profits attained through discriminatory conduct. To evaluate the effectiveness of a proposed fine, the optimal fine F^* can be compared to the proposed fine f. If $f < F^*$, then the proposed fine is too small whereas if $f > F^*$ the proposed fine is large enough (or potentially too large). Recall that fines below the optimal value do not deter offensive behavior so it is always wise to err on the side of the fine being too large.

Illustrative calculations from this formula are provided in Table 1. For simplicity, assume that the t is measured in years, the discount factor is 10%, and π is equal to \$12 (\$1 per month). One customer is provided poor service, but the effects of this act of discrimination spread to n customers. The probability of detection is either 100% or 50%. We also allow t, the number of years the customer is retained by the RBOC, to vary.

Table 1. Optimal Monthly Fines

(π = \$1 per month per customer)

	Probability of Detection = 100%			Probability of Detection = 50%		
n	1 Year	5 Years	10 Years	1 Year	5 Years	10 Years
1	11	45	74	22	90	147
5	55	227	369	110	454	737
10	109	455	737	218	910	1,475
100	1,091	4,549	7,373	2,182	9,098	14,747
1,000	10,909	45,489	73,735	21,818	90,978	147,470
10,000	109,091	454,894	737,348	218,182	909,788	1,474,696
100,000	1,090,909	4,548,944	7,373,481	2,181,818	9,097,888	14,746,961

The table makes clear the impact of systematic entry deterrence through discrimination on the optimal fine. Given our simplistic assumptions, the size of the fine is scaled by the number of customers the RBOC retains from discriminating against a single customer. If discriminating against a few customers today discourages CLECs from offering service on a wider scale, the gains to the RBOC from discrimination (and the optimal fine to deter such discrimination) can be enormous, even for low values of monthly profits (\$1 in this case).[5]

Alternatively, we can measure the financial reward from discrimination in a manner more consistent with Figure 2. For example, assume in State X there are 1 million lines growing at a 5% annual rate. To simplify, assume each line produces an annual (monthly) profit of \$12 (\$1). Without discrimination, the RBOC's market share declines (linearly) to 70% at the end of ten years (CLEC share is 30%). With discrimination, the RBOC decreases its loss of share so that at the end of 10 years it has an 80% market share. Over this 10-year period, the RBOC will reap a present value financial reward from discrimination of \$5.4 million. If the monthly profit per line averages \$10 per month (\$120 per year), the financial reward is \$540 million. If the RBOC can cut its share loss in half -- leaving it 85% of the market in 10 years -- then the financial reward is \$81 million even at a profit level of \$1 per line per month. To determine the optimal fine, the present value profit stream from discrimination must be divided by the probability of detection. In this last example, with a 50% probability of detection and punishment, the appropriate fines would be \$162 million (81/0.5).

[5] For larger monthly profits, just multiply the fines in the table by the estimated profit margin.

III. An Application: The New York Plan

In July 1999, Bell Atlantic - New York (BANY) submitted to the New York Public Service Commission its plan (the BANY Plan) for ensuring its non-discriminatory provision of wholesale services to CLECs. In some respects, the enforcement plan proposed by BANY is roughly consistent with the theory of compliance outlined above. In others, however, it is not. In this section, we will briefly review the shortcomings of the plan.

The BANY Plan's consistency with the economic theory of crime and punishment is restricted to two major areas. First, the BANY Plan recognizes that compliance is "critical to the development of competition (p. 10)" and necessary "for the CLECs to increase their market share (p. 11)." BANY correctly recognize the *intertemporal* nature of the discriminatory provision of wholesale services (as illustrated in Figure 2) requiring fines to be estimated using equation (2). Second, the plan does not measure or levy fines solely on a per occurrence basis. As described above, the effects of discrimination can extend well beyond the specific service order that is found to be "out of parity." To ensure compliance, penalties must reflect the full financial reward -- across customers and over time -- from discriminatory conduct.

The BANY plan is inconsistent with an effective enforcement plan in a number of ways. First, there is no indication of how the size of the fund for penalty payments is determined. Without question, effective enforcement requires that the full financial reward from a failure to comply with the rules be extracted from the offender. If the maximum fine is too low, then compliance cannot be expected. Second, the NY Plan does not consider the probability of detection and punishment. Even under the best of circumstances, the probability of detection is less than 100%. As discussed in Section V, the use of statistics to evaluate parity ensures a probability of detection less than 100%. Third, the BANY Plan -- through complex and arbitrary aggregation and averaging -- can mask discriminatory conduct. Complicated aggregation schemes are particularly suspect when there is no evidence that aggregation is necessary or desirable. Within the theoretical framework of crime and punishment, this feature of the BANY Plan is equivalent to reducing the probability of detection and, as a consequence, reducing the effectiveness of the enforcement program.

1. Sizing the Fund

The BANY Plan allocates a maximum of $150 million per year in bill credits to CLECs for instances where BANY is found to be "out of parity." This $150 million is allocated across the numerous performance measures. Unbundled elements, for example, are allocated $45 million per year as an aggregate category (MOE - Method of Entry) and $42 million for individual performance measures within that MOE. While $87 million might be a large sum of money, the unanswered question is whether or not this amount is *large enough* to deter discrimination.

Assume, for illustrative purposes, that absent discrimination BANY would lose 30% of its 6.44 million switched access lines (growing at 5% annually) to CLECs using unbundled elements over the next 10 years (1998 SOCC, Table 2.10). Note that this share loss is roughly identical to that experienced by AT&T over the time period 1984 to 1994.[6] According to the 1998 SOCC, average local revenue per switched access line (business and residential) is about $35 per month. Assuming that by discriminating against CLECs in the first year -- damaging CLECs' reputations and discouraging mass market rollouts of local service -- BANY cuts its market share loss to only 20% over 10 years. At a per line profit of 20% of revenue ($7) per line per month (excluding any profits from intraLATA or interLATA long distance services), the present value financial reward for discrimination equals $209 million over the 10 year horizon.[7] This large sum is only the numerator of equation (2). As shown in Table 2, dividing the $209 million financial gain by the probability of detection yields a prescribed fine that may exceed $2 billion (where $\phi = 0.10$). Clearly, in this plausible scenario, fines that cannot exceed $87 million per year will not be effective. As discussed below, the design of the BANY Plan virtually ensures that the total fines levied, even with egregious non-compliance, will be far below the maximum fines.

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[6] According to the 1994/5 SOCC, Table 8.12, AT&T had a market share of 70% of presubscribed lines.

[7] Assumes annual discounting at a 10% rate. Average profit per customer and damages are related linearly. Other things equal, every $1 in profit produces about $30 million in damages.

Table 2.

Optimal Fines and the Probability of Detection

Probability of Detection (ϕ)	Fine (F^*) (mil)	Probability of Detection (ϕ)	Fine (F^*) (mil)
100%	$ 206	50%	$ 412
90%	229	40%	515
80%	258	30%	687
70%	294	20%	1,030
60%	343	10%	2,061

What should be most clear from the table is that the penalties *do not* equal, except with perfect detection and punishment, the estimate of the financial gain to the RBOC ($206 million). Rather, these fines are the financial reward scaled by the inverse of the probability of detection. Thus, in every plausible scenario (i.e., $\phi < 100\%$), effective penalties must exceed potential financial reward from discrimination.

2. THE PROBABILITY OF DETECTION

Guaranteed detection of non-compliance is never expected no matter how many resources are devoted to the enforcement program. If the enforcement agency was lucky enough to catch all offenders, some of these will escape punishment through administrative loopholes. In the present context, even if every potential source of discriminatory conduct was included in the performance measures and punishment was certain, the use of statistical testing of parity ensures that the probability of detection is not 100% (see Section V).

As the probability of detection and punishment (ϕ) falls, the penalty must increase. Thus, without some knowledge of the probability of detection, it is impossible to assess whether or not a particular level of penalties will be effective. A number of features in the BANY Plan have the effect of diminishing the probability of detection and/or punishment.

Relationships Between Critical Measures

Under the BANY Plan, penalty dollars are divided up between an aggregate categories of MOEs (Resale, UNE, Colocation, Trunks) and the critical measures. Within the critical measure category, the dollars are again divided among each of the critical measures. Appendix B of the BANY Plan provides the detailed distribution of penalty dollars among the critical measures.

Appendix B illustrates the fact that BANY could substantially reduce competition by targeting its discriminatory conduct to any one of many performance measures. Certainly, if BANY's UNE ordering system fails (a fine of about 20% of the total penalty dollars for UNE critical measures), then BANY will never have to worry about the "mean time to repair" performance measure. BANY cannot repair a leased line never leased. Or, BANY could delay or deny colocation (a fine of about $208,000 per month) and avoid UNE critical measures for CLECs requiring only an unbundled loop since colocation is required for this mode of entry. The BANY Plan, at present, fails to recognize the inherent order of things or the relationships between the various wholesale functions it must perform if local competition is to develop. In a chain of services required for offering a competitive local service, it only takes one failure to slow down the development of competition.

Aggregation of Performance Measures

Aggregation of multiple performance measures, particularly in the manner proposed by the BANY Plan, unambiguously understates the presence of discrimination. Aggregating performance statistics, whether getting a weighted average statistic by using arbitrary "competitive significance" weights or just calculating a simple average, can mask evidence of rather severe discrimination in some areas with compliance in others. The arbitrary scoring method proposed in the BANY Plan is particularly effective at diluting and masking evidence of discrimination. For example, the scoring method proposed by BANY cannot distinguish between a (statistically significant) 2 day and a (statistically significant) 30 day delay in the provision of an unbundled element (both receive a score of -2). Clearly, there is a substantial difference between the two in terms of the CLEC's reputation and the development of competition. While a month long delay would likely bring the development of competition to a screeching halt, the scoring methodology can make the provisioning delay disappear with a few performance measures that are in parity (receiving a score of 0).

Additionally, the BANY Plan allows BANY to eliminate evidence of marginal discrimination (a score of -1) by alternating compliance between measurement periods: "Monthly performance scores of -1 are subject to change if in the following two months BA-NY obtains a performance score of 0 for the Critical Measure (p. 22)." Compliance in later periods does not alleviate the undesirable effects of discrimination in the current period. Furthermore, alternating between acceptable and unacceptable performance from period-to-period increases the variance of CLEC quality over time. Rewarding uneven performance is not a desirable trait for an enforcement plan. Mixed with the arbitrary weighting and scoring scheme, redemption substantially weakens the effectiveness of the enforcement scheme.

While we are critical of aggregation, we recognize that some aggregation may be required. As long as the penalties can be adjusted upward to account for the diminished probability of detection endemic to aggregation, there is no problem. In theory, even if aggregation makes detection nearly impossible, a large enough penalty will promote compliance. In this regard, nearly any performance plan is acceptable as long as the fines are set high enough. As illustrated in Table 2, the penalties required for lower probabilities of detection are enormous and likely beyond the realm of political feasibility. Thus, aspects of enforcement plans that reduce the probability of detection, such as the arbitrary aggregation and penalty distribution schemes of the BANY Plan, should be avoided at all costs.

Aggregation Across CLECs

Another potential problem with the BANY plan is the treatment of CLECs as a single entity. Clearly, some CLECs are different than others. MCI Worldcom, for example, has deployed twice as many voice switches across the country than has any other CLEC.[8] By targeting discriminatory conduct toward more threatening rivals, such as MCI Worldcom, BANY can effectively slow the growth of competition without facing penalties.

Allowable Misses and Minimum X's

Citing fears of finding discrimination where none is present (Type I error), the BANY Plan provides for "allowable misses," given BANY the opportunity "to record a certain number of misses without having to provide bill credits (p. 14)." In other words, the BANY Plan allows BANY to discriminate without consequence. In certain cases, there may be misses. But, the ability to exclude misses, legitimate or not, unambiguously decreases the probability of detection. Thus, by including an "allowable misses" feature, the penalties for non-compliance must be increased if the enforcement scheme is to be effective.

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[8] The 1999 CLEC Report, New Paradigm Resources Group, Chapter 8.

IV. Estimating the Financial Reward: An Application

Estimating the financial reward from discrimination requires a number of assumptions. The requirement to make a number of assumptions, some of which are more fact-based than others, should not deter the enforcement agency from doing so. Regardless of the enforcement scheme, the penalties must be sized. This task will either be methodological or arbitrary, the latter of which -- by ignoring the basic economics of enforcement presented in this document -- offers little hope of effective enforcement or of withstanding judicial scrutiny.[9] So that all parties can contribute to the debate and adjustments to the penalties can be made in the future, the estimation approach should be clearly set forth. Using equation (2), we provide one possible estimation approach below.

Equation (2) requires information on the following variables: average profit per customer (π), the number of customers retained through discrimination (n_t), the probability of detection (ϕ), and a discount rate (r). Average profit can be estimated in a variety of ways, using profit margins, cost models, and so forth. One sensible proposal for estimating the number of customers retained from discrimination (over time) might be to assume that the RBOC will lose market share in a similar manner that AT&T lost share since divestiture. In 1994, AT&T possessed a 70% market share of presubscribed lines. Thus, we might assume that the RBOC would lose 30% market share over the next 10 years. For simplicity, we might also assume this share loss occurs linearly at a rate of 3% per year (in year t, CLEC share is $0.03t$). By providing poor quality wholesale services to the CLECs, the RBOC is able to attenuate its share loss. We define α as the attenuation factor so that $\alpha 0.03t$ estimates share loss with discrimination ($\alpha = 1$ without discrimination). Setting a value for α is similar to weighting performance measures by their competitive significance. The discount rate has a range of plausible values; we assume a discount rate of 10%.

The probability of detection (ϕ) is, perhaps, the most difficult variable to estimate. Certainly, the probability of detection is less than 100% and probably above 0%. As discussed in Section V, the use of statistics (and the chosen critical values of the Z statistics) to determine parity indicates that ϕ should not exceed 85% or 95%, depending on the significance levels proposed by different parties. Even ignoring the effects of statistical testing and the effects of aggregation and penalty distributions in the BANY Plan, 100% compliance is not expected. Given

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[9] The arbitrary selection of fines is evident in penalty levels that are identical across states. The financial reward of protecting market share will be larger in states with more customers and the penalties should reflect that fact.

the complexities of measuring performance, we believe is it unreasonable to assume that the probability of detection and punishment will exceed, under the best of circumstances, 75% (3 of 4 acts of discrimination are detected and punished). Indeed, considering the specifics of the BANY Plan, a more plausible *upper bound* on detection and punishment would be 50% (the enforcement agency detects and punishes half of the discriminatory acts).

With these assumptions about the variables in equation (2), we can estimate the financial reward from discrimination. We focus on discrimination in the UNE MOE and assume that colocation is provided by the RBOC without delay. In 1998, BANY operated about 6.44 million switched access lines and we assume a 5% growth rate in access lines per year. Absent discrimination, in the 10th year BANY will operate about 7 million of a total of 10 million access lines. CLECs will service the remaining 3 million lines. At present, the average revenue per switched access line is about $35 and we assume a 30% profit margin per line for a monthly profit of $10.50.

Assume that discrimination in year 1 by BANY reduces it share loss by one percentage point at the end of 10 years ($\alpha = 0.967 = 0.29/0.30$; final market share is 71%). The present value of the financial reward from this discrimination is $31 million. At a probability of detection and punishment of 0.50, the optimal fine is $62 million. If the discrimination reduces share loss by two percentage points over the next 10 years, the financial reward doubles to $62 million and the fine to $124 million. In practice, because fines below the financial reward will not deter discrimination it might be sensible to add an additional amount to the financial reward. For example, the $62 million might be adjusted upward by a factor of (say) 1.5 (50% increase) to ensure the fines are adequately severe.

This example illustrates how the maximum penalties can be estimated in practice. How the fines are distributed and levied is another matter. The enforcement agency must keep in mind that the method of distribution and application will affect the probability of detection and punishment.

V. Effective Penalties and the LCUG Z

As can be seen from Equation (2) the optimal fine is an increasing function of the number of customers affected (n), the profit per customer (π), the time horizon defining the duration of the benefits (t), and the discount rate (r); it is a decreasing function of the probability of detection and punishment (ϕ). MCIW has for sometime suggested that penalties could legitimately be based on the value of the LCUG Z, the statistic used to test for parity. MCIW, among others, proposed that the larger is the LCUG Z in absolute value, the larger the fine or penalty should be.

This argument regarding the LCUG Z is consistent with the general view of punishment for discrimination presented above. To see this, consider the formula for the LCUG Z

$$Z_{LCUG} = \frac{\overline{X}_{CLEC} - \overline{X}_{ILEC}}{S_{ILEC}\sqrt{\dfrac{1}{m_{CLEC}} + \dfrac{1}{m_{ILEC}}}} \tag{3}$$

where the $\overline{X}$'s are the sample means for either the CLEC or ILEC, S is the standard deviation of the ILEC sample, and m is the number of observations for the CLEC and ILEC. The LCUG Z will increase in absolute value with increases in the excess of the ILEC mean over the CLEC mean, with decreases in the ILEC standard deviation, and, with larger values of m_{CLEC} (assuming that $1/m_{ILEC}$ approaches zero).

Clearly, the ILEC's expected profit from discrimination will increase as the superiority of its performance per customer over that of the CLEC becomes more pronounced. This difference in performance between the ILEC and CLEC is measured by $(\overline{X}_{ILEC} - \overline{X}_{CLEC})$. Thus, the LCUG Z is an increasing function of the superiority of the ILEC's service and its profits. As indicated by equation (2), larger values of the LCUG Z prescribe larger penalties. Also, the smaller is S_{ILEC}, the more certain we are (and are the CLEC's potential customers) that an observed means difference is not illusory. Again, the larger the LCUG Z, the larger the fine should be. Finally, just as the number of customers affected (either directly or indirectly) increases the optimal fine, so is Z an increasing function of m_{CLEC}; so again, larger Zs imply larger optimal fines.

Although MCIW's previous arguments relating to the relationship between penalties and the LCUG Z dovetail well with the optimal fine analysis, this current analysis adds two new dimensions to the discussion: 1) The time horizon for damages and 2) the probability of being detected and punished. The time dimension is completely new to the penalty discussions and an important addition to the analysis. Current increases in the profits of the ILEC (and damage to the CLEC) are only a fraction of the costs and benefits expected from discrimination. Account must be taken of the discounted present value of future profit streams and harm deriving from current discriminatory actions.

Regarding the incorporation of the probability of being detected and punished into our penalty analysis, it is important to realize that 100% detection and punishment is highly improbable. In fact, the LCUG Z statistical analysis allows us to determine that the maximum value for the probability of detection must lie below 100%. Recall that the probability of a type II error is the probability of concluding that parity exists when it in fact does not. In other words, type II error is the probability of the ILEC performing discriminatory service but not being detected as doing so. Thus, one minus this probability, i.e., [1 - Prob(type II error)], is a measure of the probability of the ILEC being detected in a finable offense. Generally, we do not know the exact value of the probability of a type II error, because it depends on the unknown value of the true means difference. But it is sensible to suggest that it is *at least equal* to the probability of a type I error. Thus if $\alpha = 0.05$, then ϕ is at most equal to $1 = 0.05 = 0.95$, so that the penalty inflation factor should be at least 1.053 (1/0.95). However, if equal risk occurs at $\alpha = 0.15$, as was suggested by AT&T earlier in the proceedings, the penalty inflation factor becomes 1.176. Assuming $150M in penalties per year (as has been suggested in the NY deliberations), ignoring the probability of getting caught amounts to not levying an additional $8M in fines in the first case and $26.4M in fines in the second case. Keeping in mind that these are only the minimum estimates of the understatement of the optimal fine (since 100% detection for practical and statistical reasons is unlikely), the errors can be sizeable.

VI. Summary and Conclusions

A number of interesting statistical questions arise when attempting to test for the discriminatory provision of wholesale services by an RBOC to the CLECs. Performance testing, however, is not an exercise in statistical theories. The goal of performance testing, and the penalties associated with those tests, is to encourage the RBOC to act in a manner inconsistent with its private interests. In order to accomplish this task, the incentives of the RBOC must be altered by making discriminatory conduct, which is profitable in itself, unprofitable by extracting all the profits acquired through discrimination with the diligent use of penalty payments. To do so, the penalties must be sized so that the expected payment of fines -- equal to the fine multiplied by the probability paying it -- equals the expected gain from discrimination. Unfortunately, this fundamental feature of effective enforcement has been ignored entirely in the BANY Plan, as well as most other enforcement plans we have reviewed. If effective enforcement is the goal, penalties cannot be sized or distributed across performance measures in an arbitrary fashion. The enforcement plan must take into account the basic economic principles at play.

Performance plans, by their very nature, will be complex and uncertainty ensures that estimates of the financial rewards and the probability of detection will be educated guesses at best. However, complexity and uncertainty are not excuses for abandoning the underlying theory of effective enforcement. If the financial reward and probability of detection are ignored, then the enforcement plan has no legs to stand on and its failure virtually guaranteed.